

Claims

1. For use with a tool for processing a work-piece at low pressure, a workpiece transfer system comprising:

5 a) a first isolation load lock for transferring a work-piece from a higher pressure region to a lower pressure region and back to said higher pressure region;

b) a second isolation load lock positioned next to the first work-piece isolation load lock for transferring a work-piece from a higher pressure region to a lower pressure region and back to said higher pressure region;

10 c) a work-piece processing station for processing work-pieces at low pressure; and

d) a robot for transferring work-pieces from one of said first and second work-piece isolation load locks to the work-piece processing station.

15 2. The transfer system of claim 1 additionally comprising a work-piece aligner for controlling an alignment of work-pieces moved through the work-piece isolation load lock.

3. The transfer system of claim 1 wherein the first and second isolation load locks comprise:

20 a load lock housing having two side entrances that open and close to allow the work-pieces to be inserted into a load lock housing interior from different directions; said housing including a support for supporting a work-piece placed on the support within the housing interior; and

25 a control valve for selectively venting a load lock housing interior to atmosphere and to a vacuum source for lowering the pressure within the load lock housing interior.

30 4. The transfer system of claim 1 wherein the first and second isolation load locks are spaced vertically from each other and wherein the robot includes two spaced apart end effectors that can be moved into the first and second isolation load locks to obtain a work-piece.

5. The transfer system of claim 4 wherein the spaced apart end effectors can be raised and lowered in relation to the load locks to allow either end effector to move into either of said first or second load locks.

5 6. For use with a tool for processing a work-piece at low pressure, transfer apparatus comprising:

 a) an enclosure defining a low pressure region for processing of work-pieces at a work-piece processing station within the low pressure region;

 b) two adjacent work-piece isolation load locks wherein each load lock includes:

10 i) two access openings for selectively communicating atmospheric pressure to a load lock interior for transferring work-pieces to and from atmospheric pressure, and

 ii) a third access opening for transferring work-pieces within the load lock interior to lower pressure for processing and back to said higher pressure
15 subsequent to said processing;

 c) a first robot for transferring work-pieces from the adjacent work-piece isolation load locks to a processing station within the low pressure region; and

 d) multiple other robots positioned outside the low pressure region for transferring work-pieces to and from the adjacent work-piece isolation load locks from a
20 source of said work-pieces prior to processing and to a destination of said work-pieces after said processing.

 7. The transfer apparatus of claim 6 wherein the adjacent work-piece isolation load locks are positioned one on top of the other.

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 8. The transfer apparatus of claim 7 wherein the two access openings of a load lock open to allow work-pieces to be inserted along different travel paths and placed on a load lock support.

30 9. The transfer apparatus of claim 6 wherein the first robot moves the workpieces in an arc to a transfer station.

10. The transfer apparatus of claim 9 wherein the first robot has two end effectors, wherein each end effector can actively grasp a work-piece in either load lock.

5 11. The transfer apparatus of claim 10 wherein the load locks are positioned one on top of the other and the work-pieces are generally flat wafers and further wherein the two end effectors move up and down along a direction transverse to a plane of the generally flat wafers.

10 12. The transfer apparatus of claim 11 wherein the two end effectors are coupled to a movable carriage that moves the two end effectors simultaneously.

13. A process for serially processing multiple work-pieces at low pressure comprising:

15 providing a low pressure robot having two end effectors for moving work-pieces to a processing station from first and second load locks positioned adjacent to each other; moving an unprocessed work-piece to a first load lock and placing the unprocessed work-piece inside the first load lock;

 lowering the pressure within the first load lock;

20 removing the unprocessed work-piece from the first load lock with one end effector of said low pressure robot and moving the unprocessed work-piece to a processing station;

 placing an already processed work-piece obtained from the processing station with a second end effector of said low pressure robot into one load lock of said first or 25 second load locks;

 raising the pressure within the one load lock; and

 removing the processed work-piece from the one load lock.

14. The process of claim 13 wherein a processed work-piece is placed into the one load 30 lock at the same time an unprocessed work-piece is being processed at the processing station.

15. The process of claim 14 wherein the work-piece is a semiconductor wafer and wherein the low pressure robot delivers the wafer for placement onto a wafer chuck that attracts the wafer and further comprising reorienting the wafer and chuck prior to processing.

16. The process of claim 13 comprising positioning one load lock above the second load lock.

17. The process of claim 16 comprising moving the two end effectors of the low pressure robot up and down to enable either end effector to access work-pieces within either the first or second load locks.

18. The process of claim 17 wherein the two end effectors are mounted collinearly to each other on a carriage that supports a drive motor for independently activating each end effector and further comprising moving the carriage up and down with respect to the load locks to appropriately position an end effector with respect to a load lock.

19. The process of claim 13 wherein the first and second load locks have access openings at an angle with respect to each other for allowing work-pieces to be inserted into a load lock from different directions from an in air side of said load lock and further comprising positioning multiple in air robots for moving work-pieces into and out of said load locks.

20. The process of claim 13 wherein the work-piece is a generally planar wafer and additionally comprising aligning an orientation of the wafer prior to inserting an unprocessed wafer into a load lock.

21. The process of claim 20 additionally comprising providing first and second in air robots for moving the generally planar wafers to and from the load lock and wherein a first in air robot gathers a wafer from a source of wafers, places an unprocessed wafer

onto an aligner for orientation and wherein a second in air robot removes an aligned wafer from the aligner for transfer through a load lock to the processing station.

22. The process of claim 13 wherein one or more additional unprocessed work pieces are moved sequentially from a source by an in air robot to the first and second load locks prior to removal of the processed work piece from the one load lock.

23. The process of claim 22 wherein alternate ones of the additional unprocessed work pieces are placed into alternate load locks of said first and second load locks to allow a predecessor work piece to be removed from a pumped down load lock while an alternate load lock is opened to atmosphere for receipt of an unprocessed work piece.

24. The process of claim 13 wherein a given work piece is removed after processing from the same load lock into which said given work piece was placed prior to processing.

25. Apparatus for serially processing multiple work-pieces at low pressure comprising:
first and second load locks located adjacent to each other;
a first low pressure robot having two end effectors which rotate about a robot center axis for moving work-pieces from the first and second loadlocks to a processing station;
a second in air robot for moving an unprocessed work-piece to a first loadlock and placing the unprocessed work-piece inside the first loadlock;
a pump for evacuating the first loadlock to reduce the pressure within the first loadlock; and
a controller for causing the first robot to remove the unprocessed work-piece from the first loadlock with one end effector of said first robot and placing a processed work-piece obtained from the processing station with a second end effector of said first robot into the second loadlock prior to pressurizing the second load lock.